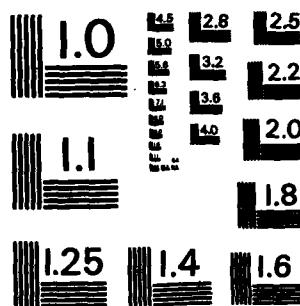


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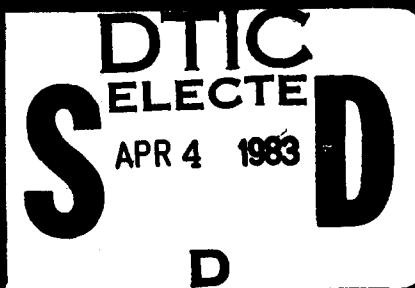
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POLAR BIOMEDICAL RESEARCH

NATIONAL ACADEMY PRESS

Polar Biomedical Research

An Assessment

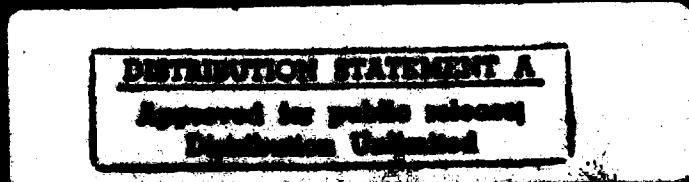


Ad Hoc Committee on Polar Biomedical Research

Polar Research Board

Commission on Physical Sciences,
Mathematics, and Resources

National Research Council



Polar Biomedical Research

An Assessment

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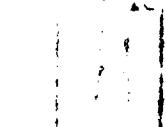
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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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William S. Benninghoff, Department of Botany, University
of Michigan
Norman A. Chance, Department of Anthropology, University
of Connecticut
Mim H. Dixon, Alaska Council on Science and Technology
Frederick C. Koerner, Department of Pathology,
Medical Center Hospital of Vermont
Frederick A. Milan, Institute of Arctic Biology,
University of Alaska
Joan Ryan, Department of Anthropology, University of
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Ex officio

Glen Elliott, Institute of Medicine

Agency Liaison Representative

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Ex Officio

James H. Zumberge, U.S. Delegate to Scientific
 Committee on Antarctic Research

Agency Liaison Representatives

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Foreword

This document is one of a series prepared by the Polar Research Board that develop strategies for polar research. These studies are expected to be sufficiently searching to guide polar research over the next two decades. The setting of priorities is particularly important in times of financial stress, and it is hoped that these studies will assist the decision makers who will be doing so in government and nongovernment organizations concerned with the polar regions.

Three studies in the series have now been completed: An Evaluation of Antarctic Marine Ecosystem Research, Study of the Upper Atmosphere and Near-Earth Space in Polar Regions Scientific Status and Recommendations for Future Directions, and this one. Work continues on six other studies, and further studies are to be initiated over the coming year.

The Polar Research Board appreciates the efforts of Chester M. Pierce, Chairman, Ad Hoc Committee on Polar Biomedical Research, and the members of the Committee in the conduct of this study and the preparation of the report on their findings and recommendations.

Charles R. Bentley, Chairman
Polar Research Board

Preface

During the next two decades, the polar regions will become increasingly important to economic, scientific, and military activities. As the human population in these remote areas increases, problems of adjustment, health care delivery, and interaction with the environment will become more acute.

Recognizing a need for further studies on human adaptation to the polar environment, the Polar Research Board established an Ad Hoc Committee on Polar Biomedical Research. Its principal objectives were to examine and summarize current knowledge of the medical aspects of life in polar regions and to define polar biomedical research needs and the most productive directions for future effort. The Department of Defense provided support for the Committee, which held two working meetings and prepared this report on its findings.

The Committee studied a broad range of topics. It was greatly assisted in its deliberations by an exhaustive state-of-the-art summary of cold physiology prepared by Frederick C. Koerner. This literature review was distributed prior to the first meeting of the Committee and is published separately as an appendix to the Committee's report, under the title Polar Medicine--A Literature Review. In addition, working papers were prepared by Frederick A. Milan, on polar biomedical research activities and facilities in the Arctic (Attachment A), and by Joan Ryan, on psychocultural conditions (Attachment B). These documents provided useful background information to the Committee on research activities and such topics as alcohol use, nutrition, community sanitation, housing (design and heating), work environments, accidents,

pollutants, mental health, recreation, environmental consequences of increased human population, and effects of increased size of settlements.

The Committee also considered those phenomena that result when different cultures come into contact and when there are changes in the original culture patterns of any of the groups, as well as human growth and development, use of leisure, sex-specific issues, health care delivery, endemic diseases, zoonotic diseases, social networks, isolation, and other stress factors in these cultures.

A third cluster of considerations included demographic variables, life style, constraints of permafrost--particularly in relation to management of water supply and waste disposal--authority and control (political, local), and government policy (funding, impact).

The Committee's aim was to integrate the findings and viewpoints of medicine, biology, and social science, to reiterate what is known, to suggest needed research, and to identify any barriers to the implementation of polar biomedical research and the application of its findings.

We hope that the following groups, in particular, will find the report useful:

1. Physicians and other health workers in, or planning to enter, polar regions.
2. Administrators concerned with policy development for polar zones, who need to know what health-related issues and problems have been assessed or should be assessed.
3. Investigators (medical scientists in basic or clinical research, as well as scientists and engineers from nonmedical disciplines), who need to review what has been studied medically in order to pursue their own inquiries.

Numerous colleagues from academia, government, the military, and industry in a number of countries gave wise and generous counsel and criticism to the Committee. Members of the health workshop at the Inuit Circumpolar Conference, in Nuuk, Greenland, in 1980, also contributed to our study. The Committee is deeply grateful to the members and staff of the Polar Research

Board for their substantive suggestions and
encouragement in the preparation of this report and to
the Department of Defense for its support of this
project.

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Executive Summary

This assessment of polar biomedical research is part of a series on research strategies for the 1980s and beyond undertaken by the Polar Research Board. The aim of the series is to review various fields of polar research and to project U.S. research needs in the high latitudes during the next two decades. The basic assumption underlying this series is that the United States has continuing vital economic, scientific, and military interests in both the north and the south polar regions. These interests imply new research priorities and approaches. Specifically, in polar biomedicine, past U.S. efforts have been relatively modest and have had little relationship to national need.

The Ad Hoc Committee on Polar Biomedical Research formed to undertake this study included physicians, social scientists, and biologists. The Department of Defense provided support for the study. Prior to the first meeting, one member of the Committee prepared an exhaustive review of cold physiology (published separately as an appendix to the report, entitled Polar Medicine--A Literature Review) as background for committee deliberations. In addition, an anthropologist and a biologist serving on the Committee prepared papers that greatly assisted the group and that are included as Attachments A and B.

As a starting point in its deliberations, the Committee attempted to identify polar-peculiar aspects of biomedicine, but, like participants in a 1979 World Health Organization (WHO) working group on health problems in Arctic regions, we were unable to find any polar-peculiar illnesses, accidents, or procedures. Medical problems that occur in polar regions occur also

in other parts of the world and in other fields, such as space research. Thus, procedures employed in polar regions and polar biomedical research findings have widespread application. Conversely, medical problems, procedures, and findings from other geographical regions and related to other fields--such as ecology, environmental monitoring, human factors, and engineering design--have implications for and applications in polar biomedicine.

Although this interrelationship is a strength of polar biomedicine and should be a stimulus to enter the field, the very lack of uniqueness has resulted also in the field's receiving less than optimum attention in medical curricula, leading medical journals, and medical symposia and meetings. The problems that the Committee identifies in regard to manpower, training, communication, and status among peers are consequences.

The Committee noted also that although a polar-peculiar medical problem has not yet been identified, the possibility of finding one still exists and should be an incentive for a continuing, active biomedical research program.

In response to the first part of its charge--to examine the status of polar biomedical research--the Committee came to the following conclusions:

1. Psychocultural factors, as compared with purely biological factors, generate a disproportionately large share of polar medical problems, and will continue to do so; therefore, greater research attention to them will be essential as development and population growth accelerate in polar regions.
2. Many data resulting from or useful in biomedical research already exist, some in the data banks of private organizations; a top priority, taking precedence over even the initiation of new research, is to foster awareness of these data and to apply them.
3. In view of the rapid population increase in polar regions over the past decade and the likelihood of continuing population growth, greater emphasis on polar biomedicine in educational programs and professional society activities and publications is urgently needed.

The Committee was charged also with considering biomedical research needs and recommending directions for future effort. In this regard, we concluded that over the next two decades the Arctic should be the site

of more intense biomedical research investigation than the Antarctic, primarily because of the rapidly increasing development in the Arctic and the attendant growth of population.

The Committee then identified specific research needs in three fields of polar biomedicine and offered recommendations addressed to them. We recommended as highest priority for biological inquiries the integration of basic medical science with clinical medicine. In addition, biometeorological studies and studies on conservation of water supply and disposal of waste should receive special attention. In social science, the highest priority should be research dealing more precisely with the features that contribute to a positive "quality of life" in polar regions. Such features will be instrumental in ameliorating problems arising in the workplace, workforce, and home life of polar inhabitants. Study of the impact of such features could be crucial in achieving a better understanding of behaviorally based diseases, which are prominent in the high latitudes. In medical science, the Committee's highest priority was the need to clarify the relationship of health in the high latitudes to photoperiodicity, chronobiological alternations, cold, isolation, and, in some cases, high altitude. We also pointed out that valuable inquiries could be made using various cold-injury protocols in collaborative research. Further, there is compelling need for studies of cohorts over time to discover whether there are differences in health and accident vulnerability for those who live or have lived in polar zones.

Throughout the report, the Committee emphasizes the importance of instituting a number of educative strategies to promote health and to prevent illness. These strategies include public health education, professional training and development, and efforts to orient and better inform those who will become dwellers in polar regions in the future as development in these regions continues and increases.

Finally, the Committee emphasized that it is critically important to involve Alaskan Natives (Eskimos, Aleuts, Athabascans, Tlingit, and Haida) fully in the planning and execution of any biomedical research undertaken in the U.S. Arctic.

Introduction

Compared to those who work in other disciplines and specialties in the high latitudes, biomedical scientists are less concerned about the elaboration and development of expertise that is peculiar to the polar regions. The problems and solutions of biomedical sciences in the polar regions occur in other environments as well. Thus, ongoing biomedical technologies applied to problems encountered in high latitudes generally require less modification than do technologies of other disciplines, such as earth sciences or oceanography.

Current economic and demographic data suggest that during the 1980s more people will live in polar areas. For example, the 1980 census data show that the population of Alaska increased by one third between 1970 and 1980. Over that same interval, the population of three principal cities, Anchorage, Fairbanks, and Juneau, increased 260 percent, 53 percent, and 222 percent, respectively. Wherever people congregate in large numbers, there are problems related to land use, conservation of flora and fauna, and provision of an adequate supply of water that is safe for human consumption. It is in this context that biomedical needs arise; therefore, the Committee's task was to evaluate the biomedical consequences of such problems, particularly when cultures are in conflict or undergoing rapid change.

A description of the scope of circumpolar health was developed by a working group of the World Health Organisation (WHO) concerned with health problems among local and migrant populations in Arctic areas (see Attachment A). By adding the word "or" (in parentheses

in the following quotation), we can use this description in our study, which includes both the north and south polar regions (WHO 1979):

Circumpolar areas are characterized by extreme climatic conditions and a widely scattered population. The populations are natives in a process of acculturation and/or migrants in possession of an adequate technology for the exploitation of the natural resources of these areas. Most circumpolar health problems are not specific but are met with in other regions of the globe under similar circumstances. Only their combination is unique, justifying the term circumpolar health and specific actions.

To identify polar biomedical research needs, the Committee members pursued several directions of inquiry: the medical scientists considered polar-peculiar conditions that threaten life; the biologists focused on the impact of the environment on health; and the social scientists reviewed social change and acculturation.

Several unifying themes emerged in the Committee's discussions. First, polar biomedical research must be concerned with sociocultural factors. Second, economic influences, such as density and distribution of human populations and constraints on the availability of research funds, could make the Arctic a greater concern than the Antarctic for the U.S. biomedical research establishment. Third, we agreed that polar biomedical research should emphasize health over disease and prevention over treatment.

DEFINITION OF POLAR ZONES

Although our charge was to address problems generated and sustained in polar regions, we found that issues related to subpolar regions could not be entirely excluded. To project polar biomedical research needs based on definitions of the polar zones derived from geography (e.g., beyond the Arctic or Antarctic Circles) or biology (e.g., beyond the "tree line") was not meaningful. The biological, medical, and social problems of circumpolar communities are related to some extent to special characteristics of high-latitude

environments. Not all of those characteristics are associated exclusively with high latitudes, but in combination they do define a unique configuration.

Certain characteristics intrinsic to high-latitude environments place major constraints on human activity; others pose special problems for technologies transported from lower latitudes. Table 1 presents examples.

All of these characteristics have far-reaching biomedical significance, especially in relation to anticipated public health needs resulting from large-scale migration to polar environments.

CONSIDERATIONS IN ARCTIC AND ANTARCTIC BIOMEDICAL RESEARCH

The Committee found it difficult to differentiate the problems of the north and south polar zones. Because there are many more people in the Arctic and commercial exploitation is occurring more rapidly there than in the Antarctic, we focused our attention primarily on the northern high latitudes. However, even if most U.S. polar biomedical research is conducted in the north polar zone, we believe that a biomedical research program in Antarctica is justified, especially when it can be conducted in conjunction with the programs the United States sponsors in Antarctica as a Treaty Nation and participant in the Scientific Committee on Antarctic Research.

There is no reason to assume parallel biological activity in the north and south high latitudes. Useful comparative medical investigations could be undertaken in both polar zones to determine possible hormonal alterations, changes due to photoperiodicity, sleep habits, and clinical/subclinical hypothermia. Work, light, and exposure to cold in the two polar zones could be contrasted to explore physiological and psychological changes. For human biology, field experiments in the Antarctic represent controlled studies with a selected, transient population, which is almost entirely white, male, and adult. The Arctic laboratory is less controlled because there is a

TABLE 1. High-Latitude Environmental Constraints

| Environmental Characteristics | Major Consequences |
|---|---|
| Sustained deep winter cold | Restricts outdoor activity and transport |
| Strongly contrasting seasonal photoperiod | Restricts outdoor activity in winter, complicates daily routines, and has psychological effects; extends daily interval of human activity in summer, also producing psychological effects |
| Water frozen most of year | Creates problems of water supply, waste disposal, fire fighting, and safety |
| Permafrost soils | Create problems of water supply, waste disposal, and safe foundations for structures |
| Breakup and thaw | Severely restrict surface travel during late spring and early summer |
| Absence of significant agriculture and silviculture | Requires dependence on imported food and fuel |
| Attenuated solar spectrum | Reduces ultraviolet radiation, leading to possible vitamin D deficiency |
| Atmospheric temperature inversion in winter | Tends to trap air pollutants, including some from mid-latitudes |
| Great distances between settlements | Lead to increased costs of supply, medical evacuation, and related services |

broader social network (both Native Alaskan* and migrant), including people of varying ages and backgrounds and variable lengths of residence. The types of people who go to the Antarctic and their way of life there differ greatly from those in the Arctic. Those in the Antarctic could be compared to astronauts in orbit. Further, biomedical research on persons in Antarctica would have to take into consideration such factors as the careful medical selection and screening of personnel who "winter-over" in Antarctica. Comparative studies of the Arctic and Antarctic could also help to differentiate environmental changes resulting from "natural" variations (i.e., in the Antarctic) and those that result from human occupation and the application of technology (i.e., in the Arctic).

In a discussion with the Committee, Jean Rivolier, secretary of the Working Group on Human Biology and Medicine of the Scientific Committee on Antarctic Research, outlined other advantages of conducting biomedical research in the Antarctic. Social and psychological data on isolated small group dynamics continue to be useful and indicate the need for more sophisticated studies that would include biological factors as well as the traditional psychosocial factors. Further, in the Antarctic, special ergonomic studies might indicate the extreme limits for human performance under climatic duress. Variations in strength, performance time, heat exchange, accuracy of labor, and endurance could be investigated in this environment in a way that would not be possible elsewhere. Finally, a long history of cooperative international studies makes the Antarctic a place unparalleled for multinational scientific collaboration. In addition to the usual benefits from such endeavors, a more refined knowledge of small group, international cooperation could be extremely valuable as the world moves toward solving common planetary and extraterrestrial problems.

*In this report, we use Native Alaskan to refer to anyone born in Alaska, and Alaskan Native to refer to Eskimos, Aleuts, Athabascans, Tlingit, and Haida. When territories other than Alaska are included, Native is used to refer to the ethnic groups mentioned above.

GENERAL APPLICATIONS OF POLAR BIOMEDICAL RESEARCH

In general, research is either discipline-oriented or problem-oriented. For the biomedical sciences, neither discipline-oriented nor problem-oriented approaches are likely to be polar-peculiar, and findings of research done in the polar areas could have widespread, direct application in other parts of the world and to problems in other fields. For example, research on isolated communities in scientific or industrial sites in the polar regions is useful to those planning space exploration flights, for in many respects the conditions are identical. Research on a problem such as how to provide sophisticated emergency medical services to isolated polar areas could lead to logistic and technical developments that would be useful in many places where medical expertise is remote from a human settlement. Functional aspects of polar living, such as the shelf-life of drugs in a medical dispensary or maintenance of medical equipment under extreme conditions, might well be applicable outside polar areas. Increasing the present knowledge about hypothermia, or thermoregulation, and immunochemical responses in polar zones could have far-reaching implications for medical service all over the world. Thus, the rationale for the conduct of biomedical research in polar regions may be more apparent than that for other fields of polar research.

SCOPE OF THE REPORT

The Committee identified several general high-priority directions for polar biomedicine over the next two decades, and, within medical, biological, and social sciences, we also outlined sets of research activities responsive to the principal current and future needs we perceived. Because of time constraints of this study, we did not explore in detail and specify the research required in such broad medical fields as reduction of occupational health hazards, alleviation of zoonotic disease, anesthesia (especially "makeshift anesthesia" in emergencies), difficulties following snow blindness, or improvement of skin care, any one of which could serve as the focus of a separate study.

Because we found nothing that was polar-peculiar in biomedical research or its applications, the sheer

numbers of published articles that could be relevant to biomedical research in the polar zones precluded comprehensive review. In biology alone, there are an estimated 400,000 nonclinical publications each year (David E. Davis, president of the Board of Trustees of Biological Abstracts, personal communication, September 1981). However, although we were not able to identify any polar-peculiar biomedical problems, we believe that the possibility of discovering polar-peculiar illnesses is another reason for developing and maintaining a vigorous biomedical and behavioral research program in polar regions.

Our recommendations reflect what we regard as the most pressing current biomedical concerns from the medical, biological, anthropological, psychological, and sociological points of view.

Medical Science

Medical scientists on the Committee recommended research addressed to the life-threatening aspects of polar existence, as well as to means of preventing illness and trauma. They considered how and why people die in the high latitudes; this inquiry resulted in three high-priority categories of need: (1) development of a comprehensive registry for health and illness, (2) basic research, and (3) improved programs in polar biomedical education.

NEED FOR A COMPREHENSIVE REGISTRY

The Committee agreed that rather than new questions for investigation the chief need and highest priority in polar biomedical research is the organization, synthesis, transfer, coordination, and use of existing data. As a byproduct, such an effort would reveal gaps in knowledge and needed research. Because there are so few people in the Antarctic, most of the data compilation and distribution would be concerned with studies in the Arctic.

The state of Alaska has published a number of volumes on its health and vital statistics (State of Alaska 1979, 1980, 1981). In addition, there are numerous other sources of material including data from the U.S. Public Health Service, the armed services, private industry, and other countries with circumpolar populations. Although all these sources are accessible, we found that the financial resources have not been made available to seek specific information or to correlate data for research purposes. The spirit of

cooperation and openness far exceeds the available money to integrate source material in order to find and benefit from useful data.

If funds were provided for such an activity, we emphasize that care should be taken not only to ensure confidentiality but also to ensure that the data are never used with racist intent or consequences. At a minimum, Alaskan Natives must be partners in the development and operation of any registries in the northern polar regions.

After the information is catalogued, the data could be used in the following ways:

1. Verification and quantification of "established perceived problems," for example, increased accidents, suicides, spouse and child abuse, psychological effects of isolation (loneliness), family separation and readjustment associated with foster care, alcohol abuse, incidence of tuberculosis, new strains of venereal disease, and hepatitis.

2. Tabulation of changes in incidence and prevalence of accidents and sickness in relation to variables of time, location, circumstances, age, sex, and race.

3. Identification of groups that might have special susceptibility or resistance to common illnesses. For example, Greenlandic Inuit, compared to Danes (to whom almost all of them are related), have increased incidence of lung, uterine, and nasopharyngeal tumors; a low rate of coronary disease but a marked increase in heart blocks, requiring the placement of a pacemaker; a dearth of diabetes, especially of the juvenile-onset variety; and an unexpected reversal in ulcer location (more gastric than duodenal ulcers).

4. Generation of lists of agencies and people engaged in relevant research.

5. Development of abstracts to be circulated to investigators and practitioners to increase awareness of available information and new data.

An example of the type of registry we consider useful and a possible model for the compilation and synthesis for which we see a need is the Danish Data Guide 1979.

BASIC RESEARCH NEEDS

Based on a state-of-the-art review of polar biomedicine by Frederick C. Koerner (see separately published appendix to this report entitled Polar Medicine--A Literature Review), we concluded that hypothermia is not a critical factor in how and why people die in polar regions. In fact, studies that could be done in high latitudes could also be done in temperate zones, where there are perhaps more cases in which hypothermia is a feature (and often is little understood). We found no specific polar-peculiar illnesses, procedures, or techniques that demand investigation in the next two decades. We also believe that present biomedical technology can be satisfactorily applied to the health and accident problems likely to be encountered in the high latitudes between now and the close of the century and that ongoing worldwide research to improve medical technology can be applied to the problems of those living in polar zones.

Our conclusions, that people die of the same causes in polar regions as in other parts of the world and that procedures and technology developed elsewhere are applicable to polar illnesses, do not imply that polar biomedical research is unnecessary. The possible existence of a polar-peculiar disease or illness cannot be ruled out. Further, research in the polar zones might accelerate improvements that would greatly benefit people living in other regions. Problems for possible inquiry are the functional capacity of the immune system, circadian rhythm, wound healing, and cold injury. As other studies of the Polar Research Board have pointed out, research on the possible effects of photoperiodicity and electromagnetic fields can be studied in both polar zones and could be of particular value.

The Committee identified two special high-priority needs in regard to polar biomedical research that should receive attention.

Improved Understanding of Human Growth and Development: Abstracts of research conducted in polar environments indicate a sustained and broad interest in human growth and development (Siberian Academy of Sciences 1978). The ways that development is affected by life in high-latitude regions are not well understood. We believe that a high-priority research

need is to follow growth curves and the onset and course of "natural disease" in a number of high-latitude populations (cohort studies). In Alaska, these populations would include migrants and Native Alaskans; in the Antarctic, the possible impact of varying lengths of residence should be evaluated.

At present, we know little about the health risks, if any, for an individual who has spent all or some period of his or her life in the polar zones. The inquiries would be complicated because of confounding variables such as differences in diet, changes in sleep habit, amount of exposure to cold or photoperiodicity, genetic endowment, type of activity, habitat, and the like. In some cases, effects of residence at a high altitude would have to be included as well.

We must emphasize also that residence in a high latitude might confer many advantages. In general, the strengths that are used and developed, and the benefits that accrue from existence in an extreme environment, have received little or no study. As more people migrate to, or work for a time in, polar regions, these benefits, as well as the hazards, should be explored. A better understanding of life styles and attitudes could be applicable to many situations other than high-latitude ones.

Alaskan Native Participation: Between June 27 and July 1, 1980, the Second Inuit Circumpolar Conference (ICC) took place in Nuuk, Greenland (see Attachment A). There, the indigenous people of the high northern latitudes approved a charter and made resolutions aimed at establishing an international confederation. The resolutions that deal with circumpolar health are pertinent to this report. The participants were unwavering in their desire to have greater control over their own health and the delivery of their health services.

The ICC called for

1. Study of radiation exposure and the possible consequences in the Arctic.
2. Studies of foster care, with special emphasis on the etiology of separation of children and ways for reunification of children with their families.
3. Ethnobotanical studies of specific herbs--including pharmacodynamics, and psychological and

physiological studies of patients before and after administration of the herbs.

4. Exploration of the feasibility of a registry of illnesses in the several Inuit health authorities.

5. Research into methods for training administrators, community health aides or paraprofessionals, and professionals.

6. Research to increase effectiveness of practicing paraprofessionals; for example, modification of a WHO-programmed system of case history taking for use in many parts of the world.

7. Psychological, sociological, and physiological studies of alcoholism among the Inuit.

8. Studies of nutrition, environment, and sleep.

We endorse the resolutions of the ICC, and we strongly recommend provision for the participation of Alaskan Native groups in the planning and conduct of any biomedical research undertaken in the U.S. Arctic. We believe not only that there is an obligation to ensure such participation but that it is crucial to the effectiveness, meaning, and application of the research.

PROBLEMS IN MEDICAL EDUCATION

Need for Health Manpower and Policy Research:
Policies and planning for the delivery of health services in polar areas require additional research on health manpower and health care delivery systems. It is essential to determine what types of equipment and facilities and what types of medical personnel are required in particular areas. Such needs are related to many social, political, economic, defense, and other considerations. Wherever medical facilities are located and whatever the degree of medical sophistication of the personnel at the site, both Native Alaskan and migrant populations will expect and demand accessible, definitive, and high-quality health care. The morale of a local population is related in part to the effectiveness with which medical emergencies and trauma are handled. Policymakers must be aware of the expectations and needs of the populations inhabiting high-latitude regions. With the rapidly increasing population in northern polar areas, problems of adequate facilities and sufficient trained personnel will grow. Failure to meet perceived needs could result not only

in social dissatisfaction but also in diminished productivity.

Some research has begun on health manpower and health policy issues in the Arctic (Stillner, in press; M.H. Dixon, Alaska Council on Science and Technology, unpublished manuscript, "Recruitment and Relation of Health and Mental Health Professionals in Rural Alaska: A Review of the Literature," 1979). More research based on demographic, social, and commercial projections is needed. Specifically, research is needed on recruitment and retention of health and mental health professionals in remote rural areas, on the effectiveness and efficiency of using paraprofessionals (such as the community health aides in Alaska) for primary care, on evaluation of models for the delivery of industrial health services in telecommunications and electronic media to promote the treatment and prevention of illnesses and accidents, and on other issues related to the structure of health care delivery systems.

Educational Programs: The Committee believes that biomedical research in the polar regions of the United States has been handicapped by the absence of graduate and postgraduate educational opportunities in the social, behavioral, and health sciences and by the virtual exclusion of polar concerns in the formal and informal structures of most medical education programs. Because most undergraduate, postgraduate, and continuing medical education programs lack polar-specific content, polar medicine receives little attention or emphasis in the chief medical journals or at major medical conventions. As a result, U.S. biomedical scientists do not give serious thought to problems in the high latitudes. We believe that by stimulating young biomedical scientists to consider the importance and challenges of polar biomedical research, a marked improvement in the quality and quantity of such research would result. To achieve the desired upgrading of research effort in polar areas would, of course, require the allocation of funds for this purpose.

As the United States reexamines its policies concerned with polar regions, especially in the Arctic, governmental, private, and military organizations might well consider a number of simple steps that they could take to foster biomedical research. Past experience

provides examples of ways to attract additional manpower into particular fields or career paths--for example, into pathology and psychiatry in the 1950s, into family practice in the 1960s, and into cardiovascular and cancer research in the 1970s. Among the means employed were provision of increased training and research funds and of special undergraduate and post-graduate fellowships, fostering meetings and presentations by eminent educators and researchers in a particular field, and encouraging and supporting the publication of proceedings and symposia resulting from such gatherings. In addition, it has been recognized that many professionals come to Alaska not primarily because of specific interest in polar research but because they are attracted by the living and working conditions; therefore, policymakers might consider ways to encourage young professionals to reevaluate northern high-latitude regions as a place to live. The objective would be to increase the pool of indigenous scientists and clinicians from whom researchers could best be developed.

Alaska is now debating the development of a full four-year medical school. In the meantime, and regardless of the outcome of the deliberations, much could be accomplished by sponsoring seminars and programs on high-latitude medicine in Alaska. Though the principal emphasis might be on service and educative aspects, ideas for research would almost certainly be generated as well.

Communication of Research Findings and Needs:
Directly related to education of the health care community and the general public about the needs and opportunities in polar biomedical research are improved management and use of biomedical findings and data. The Committee agreed that research interest would increase if means were found to communicate more about the ongoing scientific problems and achievements in northern and southern polar regions. There was consensus on the need for an interdisciplinary, polar-specific, biomedical and biobehavioral journal on circumpolar health. The format of such a journal could include abstracts and short publications of research. The intent would be to make research findings more readily accessible and widely known and to direct the interested reader to more detailed sources.

As awareness of the resource potential of the polar regions grows, industrial exploration and development are increasing. The activities of private firms are generating a variety of data, some of which are relevant to biomedicine. Within the limitations imposed by proprietary interests--and we would expect these to apply less to biomedical data than to data of a number of other disciplines--we recommend that arrangements for the availability and use of the data developed by industry be explored. For example, the biomedical data from oil or construction companies concerning the nature of visits of their personnel to physicians could be useful in research.

To facilitate the sharing of information, we believe that there is need for expert "supergeneralists," who would be capable of monitoring information from diverse specialties and communicating across disciplines. To find or develop such individuals may well be difficult, but their value would be great in this diverse and decentralized field. A supergeneralist in polar biomedicine would serve as a social heuristic epistemologist to coordinate information among specialties and to put people in touch with others with like interests or with the data they were seeking.

Social Science

To place health research needs in a social context, the behavioral scientists on the Committee sought published data and research regarding family dynamics, violence, alcohol abuse, and industrial hazards in polar regions, all of which have implications for health. They found few published data on such problems, which appear to be root causes of many disorders requiring medical intervention. In fact, the needs for polar biomedical research are more apparent in sociological and behavioral fields than other fields of biomedicine and perhaps least well met in these fields.

Rapid social and cultural change, cultural conflict, and issues related to environment and ecology underlie many of the biomedical problems in both polar zones. To resolve such problems in the Arctic, it is crucial for Native and non-Native populations to coexist and interact harmoniously. Alaskan Natives have asserted and formally documented their right to determine policies affecting their lives, including their health; thus they must participate in the development of policies on biomedical research and their implementation. Further, because Alaskan Native peoples are a crucial element, distinguishing this polar area from others in the Arctic, they are likely to be the groups sampled in any biomedical or biosocial research. Therefore, it should be the obligation of all biomedical researchers, Alaskan Natives or other Alaskans, not only to follow customary informed-consent procedures but also to seek Alaskan Native community approval and consultation on research policy recommendations, research design, and the conduct of research. (This point was also emphasized in an earlier report of the Polar Research Board (1977).)

The Committee identified five high-priority problems for which greater social science research effort is needed and suggested types of studies that might be undertaken. The categories are alcohol abuse, accidents, employment, family relationships, and adjustment to change. (Violence is associated with several of these problems and is included in the discussion of them.) The breadth of these categories, the diversity of the research needs in each, and the large share of polar biomedical problems generated by psychocultural factors led the Committee to assign a top priority to this field of research over the coming decades.

ALCOHOL ABUSE

Throughout history, in many parts of the world, excessive drinking has been attributed, at least in part, to stressful conditions. Today, this belief still prevails, and, in addition, we know that alcohol consumption is directly associated with death by suicide, homicide, or accident, and with adverse effects on a fetus.

In the United States, young people are especially vulnerable to events of violence. Research in Alaska indicates that the population has a disproportionately high percentage of young people, compared to other states (U.S. Bureau of the Census). Not surprisingly, therefore, Alaska has lower rates of heart disease, cancer, and other chronic illnesses that tend to accompany old age, and higher rates of death due to accidents, suicide, and homicide (State of Alaska 1981). Yet, even when death rates are adjusted by age, Alaska has higher death rates for behaviorally based health problems than the other states (State of Alaska 1981).

At U.S. bases in the Antarctic, there is liberal consumption of alcohol. To our knowledge, although there have been serious drinking problems in individuals, alcohol consumption has never jeopardized or diminished the effective overall conduct of a station's task. Despite the paucity of numbers of people in the Antarctic, it might be useful to look more carefully at alcohol consumption in relation to behaviorally based health problems, especially accidents and mental illness, job satisfaction and performance, and

subsequent life adjustment. Such studies might well be extended to the subsequent life adjustments of family members who had been separated by work assignments in polar zones.

Preliminary evidence suggests that per capita consumption of alcohol is greater in circumpolar areas than in other parts of the world. Yet, in the U.S. Arctic and Antarctic, there is little research on alcohol-related problems. A more thorough approach to the assessment of alcohol-related research needs in polar regions would require a review of the alcohol-related research conducted in other areas. For example, studies among other Native American groups, physiological studies, and studies of the outcome of alcohol-education programs might have applications in circumpolar areas. Conversely, research in polar regions could have applications in other geographic areas. The multinational, multicultural characteristics of the circumpolar region provide an excellent opportunity to test hypotheses regarding the extent to which cold, isolation, darkness, physical and physiological attributes of race, public policy, employment, social structure, and other variables affect alcohol consumption. As with many medical research projects suggested by the Committee, international or interagency sponsorship might be the best way to ensure coordination of such effort. The World Health Organization, the Inuit Circumpolar Conference, and the Alaska Council on Science and Technology are organizations that could provide coordination.

In most parts of the United States, there is a relationship between alcohol abuse and the abuse of other drugs. Clinically, for example, it is not uncommon to find the same individual abusing alcohol, paraldehyde, and barbiturates, or alcohol, marijuana, and amphetamines. Whether such combined abuse exists in the circumpolar areas is not known. However, the high rate of alcohol consumption in circumpolar areas and the suggested association with abuse of other drugs offer research possibilities that could have far-reaching implications in family dynamics, productivity, and law enforcement.

ACCIDENTS

Circumpolar people are high-risk populations for accidents. The accident mortality rate in Alaska is 92.9/100,000, nearly twice that of the United States as a whole (Northern Alaska Health Resources Association 1981). Accidents are a leading cause of morbidity and mortality in Alaska, yet little research has been done on causes, patterns, and prevention of accidents in Alaska (State of Alaska 1981). Highway traffic accidents have been studied in the contiguous 48 states, but in Alaska automobile accidents account for less than one third of the accident mortality. Because of environmental and lifestyle differences, Alaskans have significantly higher rates than the national average for small airplane accidents, drownings, and animal attacks. High accident rates in the Arctic present an opportunity to study varied causes of accidents. Results of such research would have broad application in the development of safer technologies, better emergency medical responses, and accident-prevention strategies.

NATURE AND SETTING OF EMPLOYMENT

Several work patterns predominate in the polar regions: (1) the isolated work setting, such as a construction camp in the Arctic or a scientific research station in either the Arctic or Antarctic; (2) small communities of nonindigenous professionals and service providers who have been recruited to serve in the Arctic; (3) subsistence activities as major work activity, particularly among Native peoples who follow a traditional way of life; and (4) migration of Native peoples from their villages for seasonal, temporary, or permanent jobs. Unemployment, which exists in Alaska at rates greater than in the other states, must also be considered.

With the exception of subsistence activities, all of these work patterns are characterized in general by short-term service in jobs in relatively small communities. The structure of work creates a pattern of entry into, exit from, and reentry into polar environments. Unlike the employment model that predominates in most of North America, persons who work in the polar zones are often separated from their

families for long periods of time. In the polar regions, work often is the only reason that people live in a particular place. They do not participate in a community life outside the workplace. This situation might present special social configurations that could create greater stress for workers and their families than the stress associated with climatic conditions, annual variations in light, and the psychological impact of geographical isolation.

Worldwide demand for natural resources and national policies to encourage the extraction of those resources from polar regions are increasing. The workforce that is expected to participate in large-scale construction projects for the extraction, transportation, and processing of natural resources in the Arctic is different from the largely professional and carefully selected workforce currently in the Antarctic. Although the Antarctic has been considered an ideal laboratory for the study of physical and psychological functioning in cold regions and isolated settings, the results of those studies might have limited application to a different type of workforce in a different setting in the Arctic. Yet, the study of medical problems in the Arctic workplace could have much relevance in the Antarctic, if and when large workforces arrive there.

Some of the independent variables that might be significant for studying workers in the Arctic are the balance between work and leisure; the organization of the physical and social setting (such as living space, recreation area, and dining area in construction camps); motivation and rewards; sex-specific variables; discrimination against and harassment of minorities; and hazards of the workplace and the job. These independent variables are probably more important than climate and isolation in determining health (for example, the occurrence and outcomes of accidents, mental disorders, physical disorders, and alcohol and drug abuse), as well as in their effects on such dependent variables as worker productivity, job tenure, and family stability. In addition, the recent migration to Alaska of unemployed persons from the lower 48 states suggests a need to study the social problems they cause and the difficulties they experience. Again, the findings could have implications outside the polar regions.

Studies of the health and mental health of workers in Antarctica (Mullin 1960, Palmai 1963, Nelson 1965,

Smith 1966, Popkin et al. 1974, Rivolier 1975) have focused predominantly on the effects of isolation and small group dynamics on the mental health of scientists and military personnel. Temperate zone studies have substantiated the relationship between a stressful work environment and physical and mental illness (Buck 1972, Cobb and Rose 1973, House 1974, Caplan et al. 1975, Frankenhaeuser and Gardell 1976, Karasek 1979, Karasek et al. 1981). A study by LaRocco et al. (1980) suggests that social support can reduce the physical and mental effects of occupational stress. These and other studies conducted outside the polar regions have implications for workforces in the high latitudes, but the findings cannot be generalized to these regions without field studies to test the hypotheses with the types of workforces that are located in the high-latitude work setting. The professional and service workforce in the Arctic consists primarily of teachers, health and mental health professionals, social workers, engineers, geologists, public safety officers, and administrators. As health, education, and social services are expanded in the Arctic, there is a growing demand for professionals to serve in the remote villages and service centers. A review of the literature on recruitment and retention of health and mental health professionals in rural areas (Dixon, unpublished manuscript, 1979) suggests that factors such as the integration of the professional into the community, motivations for taking rural jobs, and career opportunities are key variables in retention that deserve further inquiry. Thus, a useful variable for research in the Arctic may be social integration, rather than social isolation, which has been studied in Antarctica. In Alaska, public health officials calculate that there is a tremendous financial burden associated with faulty social integration, which contributes to high turnover of personnel (Stillner, in press).

Several studies have linked unemployment to illness (Brenner 1971, 1973a,b, 1975, 1976; Eyer 1977). A recent study suggests that economic expansion increases the incidence and prevalence of accident injuries (Catalano 1979). Unusually high rates of unemployment, an economy that is characterized by boom-and-bust cycles, and seasonal workforces in the Arctic make the relationship between unemployment and health a significant issue for further research. Among Eskimos

in the Arctic, the relationship between employment, unemployment, and subsistence activities has implications for cultural identity, which in turn affects mental health. In the dominant cultures of the United States, one might expect an inverse relationship between unemployment and nutrition. However, when the variable of subsistence activities is introduced in the Arctic setting, relationships between employment and nutrition may be more complex.

FAMILY

The exploitation of polar resources will provide work opportunities that will bring more families to the high latitudes. In the Arctic, an increase in migration will lead to an increase in interaction with Native and non-Native peoples already in residence, with possible effects on family stability, mental and physical health, accident rate, and alcohol and drug abuse.

In addition to the impact of workplace and workforce factors on the family, there are several other factors that merit research. These include the effects of separation-reunification cycles on the family, the special problems of females in a polar society, and the possible sequelae of relative affluence.

In- and out-migration on a seasonal or permanent basis, as well as "rest and relaxation" intervals away from work, can lead to all manner of separation-reunification problems in families. An abundance of literature, such as reports on military families, suggests the need for study (Isay 1968, Weybrew and Molish 1979, Weybrew and Noddin 1979). A cycle of recurrent separations and reunions can be difficult. Fathers, mothers, and children commonly exhibit a feeling of guilt, anger, envy, loneliness, or relief during these cycles. Frequently, reunions are characterized by stormy struggles over control of family finances or discipline and by ambivalence. Definition of self and self-image may be adversely influenced by recurrent separations. These factors, especially in situations of isolation and a harsh environment, could significantly increase the incidence of behavioral illnesses and accidents and the dissolution of families, all of which can affect job satisfaction and productivity.

In addition to the issue of separation and reunion of families, family health and mental health problems are associated with patterns of entry, exit, and reentry in polar zones. Research on the effects of such migrations within the family and on its interaction with others could yield data useful in a wide variety of situations outside polar regions and permit better predictions of family adjustment in the high latitudes.

Related to the strain on family life are many aspects of the boomtown environment, as well as problems associated with greater numbers of females in non-Native groups (see Attachment B for further discussion). There has been little systematic study of females in polar regions, and most such studies tend to be less predictive than those on males.

The arrival of female workers in greater numbers in coming decades might produce qualitative differences compared to the effects of such arrivals in the past. Female newcomers to the high latitudes in future years will have a greater awareness of and stronger ideas about their rights. Insistence on these rights, as well as an array of work opportunities, could mean that females in the polar regions will have different roles and role definitions from their historical counterparts. Understanding such differences will be essential for predicting patterns of male-female relationships and family life in the Arctic and comparing such patterns with those characterizing other sections of the United States. Such research could influence the development of policies, especially in relation to family and work (see Attachment B).

Related to economic boom situations are problems associated with the introduction of affluence, which often is accompanied by high rates of social pathology--increased incidence of alcoholism, drug abuse, prostitution, violence, racism, theft, fraud, accidents, homicides, and suicides. Studies are needed to verify this association and to find ways to mitigate the effects on family stability and society.

NEGOTIATION OF CHANGE

Throughout human history, habitual and repetitive comingling of indigenous and alien populations has occurred, with effects along a continuum from acquiescence to resistance. When different groups come

into sustained contact, some adjustment and adaptation typically take place in each. Interaction provides new perspectives and new modes of behavior that can modify the traditions and ethics of all. The degree of hardship, the consequences of assimilation or retention of traditions, and the pace and intensity of change vary with the circumstances.

The Committee concentrated on the problems of negotiating change in the Arctic, as the Antarctic has no indigenous populations. However, we are aware that, should the Antarctic become commercially enticing, the now largely cosmopolitan viewpoint of present inhabitants might become parochial and nationalistic.

The earliest residents of the U.S. Arctic lived in a world of relative stability. Given the technology they had developed and the abundance of natural resources in relation to population size, they probably could have adjusted indefinitely to this northern setting. With the arrival of Europeans in the Arctic, this pattern began to change. In the early contact period, the newcomers had to change their way of life to meet the demands of the physical environment, and they adopted the technology and skills of the Native population. In some instances, the newcomers exploited or destroyed Native populations. Since World War II, the situation has changed. Native people are adapting now as they have in the past, but the focus of their adaptation has changed from a physical setting they knew well to a new social setting. The impact of change varies among Native people of the North, but health and illness profiles, particularly in relation to accidents, violence, and alcohol abuse, demonstrate the occurrence of adaptation problems. Such problems are not limited to Alaskan Natives; similar health and illness profiles have been found among the increasing non-Native migrant population in construction camps, boomtowns, and rapidly expanding urban centers in the Arctic.

Adaptation to physical and social environmental stresses should not be the only focus of attention in studying the health of those in the northern polar zone, for, in addition to this capacity, inhabitants can also change their environment for the better. To date, research on preventive medicine has been more concerned with physical illness than psychosocial disorders; however, efforts to define the "quality of life" and "social support systems" are encouraging

(Krieger 1969, Matthiason 1970, Andrews et al. 1973, Harper 1977, Morrison 1979). The Committee regards such research as a high priority in social science over the coming decades.

In regard to quality of life, better measures of social anabolism* and catabolism** are needed. Particularly important is achieving a better understanding of motivation for living in polar regions and the way such motivation is sustained.

Recent research findings suggest that many behavioral disorders and suicides are related to support networks (e.g., kinship and friendship). Current data indicate that such networks can also protect individuals from physical illnesses such as myocardial infarct. Thus, some combination of quality-of-life choices (such as whether one smokes) and social support systems (such as marriage) could protect individuals from disease in stressful situations, such as cultural conflict. Individuals make decisions in the context of community perceptions of what is good, useful, probable, typical, or desirable. Values will differ significantly among various subgroups. Awareness of such culturally determined values is essential to any broad public-health education efforts.

Investigations about life styles and social support systems, as well as the dissemination of information for public use, require trained social scientists. Currently, there are no doctoral training programs in anthropology, sociology, psychology, nursing, or public health in the U.S. Arctic. Training programs in the Arctic would provide both the faculty base for research and future investigators with local sensitivity, interest, and access, all of which are essential to the success of social science inquiries.

*Social anabolism is interpersonal processes that promote constructive growth of the individual and the community.

**Social catabolism is interpersonal processes that produce destruction and/or stultification of the individual and the community.

Biological Science

Biological sciences are basic to the development of adequate environmental health controls, including especially management of water and wastes, and to a better understanding of food and nutrition. Correlation of research findings from chemistry, physiology, mathematics, and physics with those from biology is also required to deal effectively with these problems. Synthesis, greater coordination of effort, and integration of basic research with clinical and applied research are top priorities. As in our consideration of medical and social sciences, we experienced a convergence of ideas, reached from the various perspectives of committee members, that reinforced this conclusion.

Basic to our deliberations was the assumption that the environment is the final arbiter of human health, particularly in the extreme climates of the high latitudes. The short growing season restricts the productivity of the indigenous biota; diversity of species is relatively low; and the cycling of nutrient elements is restricted by slow decomposition. The biotic communities are sensitive to disturbance and slow to recover. Human activity (vehicular traffic, mining) can leave long-lasting scars on the vegetation and soils. There is little or no transition between used areas and the wilderness, with consequent degradation of aesthetic qualities of settlements. Such degradation can pose hazards to human health, as we discuss later in this chapter.

Many threats to human health that at first seem improbable merit consideration. For example, in most instances the nutrition of a small settlement will be improved by any local agriculture, animal husbandry, or

gardening, or the use of local game and fish. Yet, agriculture in the loessial soils of the Arctic will promote dust storms, which pose potential health and economic hazards. Although in our deliberations we arbitrarily disentangled and labeled problems biological, sociological, and medical, this example shows how great an overlap there is among these fields.

WATER CONTROL

The current UN International Decade of Water Control is a reminder that many causes of morbidity and mortality could be eliminated if all people had adequate and safe water supplies. Our health standards and overall standard of living in the United States rely on a supply of cold and hot running water that is safe, abundant, and readily available. Development of industry in any modern society depends on vast quantities of water, delivered wherever needed. On a global scale, there is cause for concern about the spread of the world's deserts, resulting from a combination of human activities and natural forces. Ultimately, all life depends on climate, which results from the interaction of the atmosphere, hydrosphere, lithosphere, and biosphere.

The high latitudes profoundly affect the world's climate. (Another study in the Polar Research Board's strategy series deals with the role of the polar regions in climatic change.) In them, much of the world's fresh water is located in the form of ice. There is need to establish a framework for management of this water supply to ensure its purity, if technology and necessity allow some of it to be redistributed. Such considerations might seem excessively long range; however, little doubt exists about the immediate need to protect and conserve the water in these latitudes as greater populations and more industrial activity arrive.

Among the salient problems that relate to health in the polar zones is the expense of melting ice and of keeping it in liquid form for purposes of consumption, commerce, and fire fighting. As populations grow, the necessary collaboration and oversight of this effort by engineers, public health officials, and biologists might require special research in both basic and applied sciences.

WASTE CONTROL

Intrinsically related to water control are sewage and waste control. An expanding population, with sophisticated industrial techniques, at sites characterized by periods of long winter freeze, permafrost, and slow decomposition, compounds the difficulties of waste control. Such conditions might influence health in ways ranging from the need to treat cases of dysentery to the need to design houses with proper regard for special environmental features.

Persistent deep cold of winter and permafrost soils give rise to problems of waste disposal. Calm air and thermal inversions, common in winter, tend to confine air pollutants near their sources. Even a few houses can generate significant air pollution, a situation that is made worse when there are general shifts from wood to coal and oil fuels. Cost of space heating leads to small dwellings in which living conditions are inevitably crowded.

Related to housing and living arrangements is the need for a new line of inquiry based on psycho-aesthetics in the high latitudes. Casualness about living arrangements and carelessness of habits about waste disposal can exert detrimental psychological effects on newcomers to polar zones, which might intensify health problems. People who view waste in McMurdo in the Antarctic or in U.S. and Canadian Arctic villages for the first time often react negatively. This waste is blatantly public and, of course, tends to be cumulative and long-lasting. There is need to study the impact of "dumps" on newcomers and other residents in terms of possible lower self-image and lower community image. Further, some people may never know alternatives to such conditions, like a myopic who never truly comprehends what he is missing until he is fitted for glasses.

Our concern is that a surrounding environment made unattractive because of indifference to the admittedly huge problems of waste control might operate in profound and subtle ways on circumpolar inhabitants. One effect might be development of an attitude that such waste accumulation is unremarkable and not extraordinary. Such an attitude and the attendant behavior might become the nidus for health problems such as dysentery. Biologists are concerned about psychoaesthetics for such reasons.

ENVIRONMENTAL HEALTH

For many years, suggestions have been made about opportunities to study a host of biometeorological influences on humans and animals in the polar zones. These suggestions include delineating possible factors that increase or decrease stress in work or nonwork situations. Some of the variables listed for study are (1) photoperiodicity effects, (2) full-spectrum light effects, and (3) strength and periodicity of fluctuations in magnetic and gravitational fields.

These and other topics continue to present intriguing questions for physiological and psychological research. Further, with current computer capability, many other correlations could be sought, for example, between data on biometeorological changes and data other scientists are accumulating on sunspot attractions and on temperature and barometric changes. At present, scientists know little about "acceptable biological limits" of meteorological forces. Yet, given the current limitations on research funds, two other aspects of environmental health should take precedence; these are problems resulting from ionizing radiation and ecological disturbances from pollutants.

Because the risk of exposure to radiation is high in Arctic regions, the 1980 Inuit Circumpolar Conference resolutions included one calling on the then Department of Health, Education, and Welfare to consider "the high body-burdens absorbed by Inupiat in the Arctic" in planning for the establishment of medical facilities, including radiation centers, in all villages, and "for radiation compensation to be determined through the course of developmental studies and examinations." The resolution indicates the alarm of inhabitants of northern polar regions about their risk of exposure from low-dose radiation. Data suggest that aerosol concentrations were greater in the Arctic than in industrial New England (Kerr 1979). There is now only limited knowledge of possible effects from such pollution as it passes through Arctic snows to enter human and animal food chains. Tracking trace elements through flora and fauna in polar regions could be especially valuable. At minimum, what is required is to monitor and assess the biological impact of the major sources of ionization and pollution at selected places in the high latitudes. Questions related to human biology would be complicated by epidemiological

variations that would include genetic endowment, duration of residence in the high latitude, life-style choices (e.g., cigarette smoking), and relative purity of the environment.

FOOD AND NUTRITION

Under conditions of sparse population, permafrost, and dearth of agriculture, it is not surprising that there is casual use and regard for vegetation. With the projected influx of population, serious agronomy efforts must be undertaken in the North. Agricultural scientists at the University of Alaska are trying to capitalize on long periods of sunlight to grow more crops in subpolar Alaska. The severity of the polar conditions in Antarctica allow no practical method for providing volumes of plant food for an expanded population. Any experiments in polar regions in food production involving geothermal heat, solar energy, hydroponics, or aquaculture might have benefits in other regions of earth or in space. However, there are more pressing food and nutrition experiments that should be undertaken to benefit the general and northern populations. The nutrition and food habits of the Native population should be accurately catalogued. In addition, the known lack of specific enzymes, such as those involved in lactose reduction, in some Native groups requires a variety of studies to understand how health is affected. The effects of shifting from a high-quality protein diet to a more typically U.S. diet should be documented, and the relationship between alcohol consumption and nutrition should be explored. Finally, studies of food preference should be undertaken to monitor the suspected increased consumption of "junk food" among children or to illuminate a phenomenon that has been a major concern in the U.S. space program--to keep astronauts eating properly. In all polar populations, there is a need to find out whether people have poor nutrition despite an adequate caloric intake.

For the general population, there is a need to develop food resources for subsistence. In the North, the development of caribou stock and fisheries might help to stabilize the economy and anticipate the coming of increased population. In the South, there is already a massive international effort to study the

biological stocks in the Southern Ocean. Finally, consistent with the definition we adopted of a circumpolar region, attention must be given to the constraints of confinement on the nutritional habits of the people. For example, does the restriction of mobility relate to alcoholism or obesity? The total health and social costs of these two illnesses alone could be greater than those for any other combination of illnesses.

BASIC SCIENCES

The biology underlying the promotion of health and prevention of disease must be integrated with information from chemistry, physiology, mathematics, and physics. Ongoing work in these fields could have many applications to improvement of human health and health care. The problem is twofold: to alert the health scientist to possible applications, and to make the basic scientist aware of medical needs.

We believe that in polar biomedicine the volume and variety of usual productive interdisciplinary interaction and cooperation are lacking. One approach to achieving improved interaction might be exploring and developing a better understanding of thermoregulation, cell freezing, and cryoprotectives through biochemistry. Another approach might be the use of genetic theory to discover possible relationships of immune systems to stress. A third example would be to explore human cardiorespiratory applications based on observations of the adaptation of animals to existence in polar regions. In all these fields, data are available on both the clinical and the basic science aspects; yet each group of scientists is often only vaguely aware of the relevant work taking place in the other discipline. New means are required to increase awareness and foster the sharing of data. The anticipated result would be more collaborative efforts and complementary medical and basic scientific research.

To achieve greater interaction between those engaged in basic science and those engaged in biomedicine in polar regions will require increased attention to planning and the development of a formal structure. At present, there is a more urgent need to provide systematic dissemination and synthesis of work already undertaken than to initiate new research. We

believe that such an approach would improve the quality of both basic science and clinical studies, and we regard this as a top priority.

Some might argue that the traditions of polar research do not encourage such interaction and that the presence of biomedical research in polar zones is both negligible and recent. Further, the usual channels for encouraging relevant interchange, such as a collegial academic environment, learned societies, and professional journals, are not abundant in the high latitudes. Finally, mid-latitude concerns are so prominent and demanding that clinicians and basic scientists tend to overlook high-latitude issues.

We suggest that a greater awareness of the advantages to both clinical and basic science from an interchange about polar pursuits could improve medical applications throughout the world. In addition, heightened awareness probably would result in more research proposals for projects in high latitudes. And the anticipated increase in the quality and quantity of clinical and basic medical research proposals could have a salutary and long-lasting effect on the quality of life and longevity in the polar zones, as well as in other regions.

Summary and Recommendations

TOWARD AN OVERALL STRATEGY

Whenever people enter environments that are extreme for them, the principal objective of medical science is to ensure human survival. This strategy characterized polar expeditions up to the 1940s. Once it has been established that human populations can survive, or even thrive, in a particular environment, the medical objective becomes delineation of those qualities and characteristics that will predict survival. This strategy dominated polar biomedical research from about 1940 to 1970 in the southern polar regions. However, when what was once experienced by but a few is experienced by many, the medical strategy shifts again. The emphasis is on conditions that will facilitate human adjustment, that is, on providing a situation in which a person can expect to be healthy, happy, and effective in family life, work, and community relationships, without crippling emotional symptoms, such as fear, anger, loneliness, envy, or greed.

We believe that U.S. development in the high latitudes in the next decades demands this third biomedical research strategy. Our recommendations are intended to outline such a strategy.

The characteristics of the natural environment constitute the background against which human modifications of that environment must be considered and the health and social interaction of indigenous and immigrant people must develop. Human adjustment to circumpolar environments has been achieved, but modern technology and explosive population growth have affected the balance that was attained.

The climate, the remaining wilderness, and the frontier life of polar regions continue to attract many people and to make the challenge of adjustment rewarding. National needs may encourage, or demand, that many accept this challenge. Our findings and recommendations deal with the polar biomedical research strategy needed to facilitate the response to this challenge and to improve and sustain the quality of life in polar and other regions.

FINDINGS AND PRIORITIES

As a starting point in our study, we attempted to define polar-peculiar illnesses and procedures, but, like the WHO (1979) working group on health problems in the Arctic, we were unable to do so. We found no medical problems in the high latitudes that do not exist elsewhere. Further, illness and injury in polar regions seem equally responsive to the treatment rationale and management followed in other geographic areas. Thus a principal conclusion of our study is that the problems, procedures, and findings of polar biomedicine can be encountered and applied in other geographic areas and in other disciplines, and vice versa.

That the findings of polar biomedical research can be broadly applied and that those of other areas and sciences can be adapted to needs in polar biomedicine might appear to be a strength of the field. But this very lack of uniqueness has led to some of the principal difficulties the field faces: the lack of graduate education programs in institutions located in polar regions, the neglect of polar biomedicine in the curricula of universities in other areas of the United States, and the absence of the information-exchange media and opportunities for peer recognition afforded in other specialties, all of which cause the needs and challenges of polar biomedicine to be overlooked. Although there do not seem to be unique polar biomedical challenges that require new methods of inquiry for solution, investigations conducted in polar zones could foster smoother adjustment by the increased populations that are anticipated over the next few decades as resource exploration and development accelerate in high-latitude regions, with attendant

problems of land use, conservation and protection of the environment, cultural conflicts, and the like.

Further, that we could identify no polar-peculiar problems does not suggest that the search for these can be abandoned; rather, it is an additional reason for maintenance of a strong biomedical research program.

Based on our review of polar biomedical research, we reached the following conclusions:

1. Sociocultural factors are dominant in shaping biomedical problems in U.S. circumpolar regions.
2. For the immediate future, rather than developing new biomedical research in separate specialized fields, the most pressing need, and highest priority, is to facilitate the exchange of information among specialties, that is, to achieve broader awareness of existing data, to stimulate synthesis and collaboration, and to explore arrangements for access to data collected by industry and government and their application in biomedical research.
3. In view of the rapid population increase in polar regions over the past decade and the likelihood of continuing rapid development and population growth, greater emphasis on polar biomedicine in educational programs and professional society activities and publications is urgently needed.
4. Between now and the year 2000, most biomedical research should be directed toward problems in the northern high latitudes; at the same time, research opportunities offered by southern high latitudes and problems to which Antarctic research is particularly well suited should not be ignored.

RECOMMENDATIONS

Sociocultural Aspects: Although we identified no polar-peculiar medical problems, we found that factors of geography, social structure, culture change or conflict, economic opportunity, and stress combine to promote certain behavioral disorders (e.g., alcoholism, accidents, suicide). Hence, in any analysis of biomedical research in these areas, issues of social and cultural patterning must receive attention. That stress resulting from sociocultural circumstances can cause illness is well known (Elliot and Eisdorfer 1982). In addition, the impact of high technology on

indigenous people is a special concern. Some problems of small and isolated settlements resemble situations in the less developed countries in other parts of the world. We believe that research on sociocultural problems and quality of life in polar areas should be among the highest priorities for the coming decade.

Specifically, we recommend

- o the development of accurate measures of quality of life. In the construction of these indicators, it must be noted that circumpolar regions, although "extreme" and challenging, also offer alternatives to certain kinds of stress. Many people go to polar regions to experience less-crowded living conditions, decreased social obligations, fewer regulations, and the pleasures of being in wilderness and participating in frontier life. There are also career opportunities in these regions, especially for young persons, and chances for rapid upward mobility.

- o investigations using epidemiological, cross-cultural, and longitudinal models to study the relationship of work, the workforce, and the home to accidents, suicide, mental illness, homicide, alcohol abuse, male-female interactions, and family and child development. Variables such as degree of affluence and work-rest cycles would be of particular importance in these studies. Factors such as photoperiodicity, cold, isolation, integration into a community, and chronobiology should also be considered. A holistic approach, assuming stresses of a biological, sociological, and psychological nature, would be mandatory. These studies would be fundamental in developing the best quality of life for the anticipated increased population in the polar regions.

Synthesis of Data: Numerous data banks exist in government and private agencies that could be integrated for clinical and research purposes. To identify critical research needs from such data banks, and new ones, such as accident and illness registries, would be feasible and would help to focus research effort. Profitable lines of inquiry could result from systematic integration, dissemination, and coordination of information from these sources. Another consideration is that solutions to many medical difficulties encountered in high latitudes are available; the reasons that they are not more readily

identified and applied must be examined. The chief constraints appear to be political and economic decisions that determine priorities and the level of effort. The barriers to more effective use of information and data should be studied and effort directed to reducing them. We view this as a top priority in polar biomedical research over the next decades.

Ongoing collection, collation, analysis, coordination, and dissemination of health data from polar zones would assist in determining polar health needs, evaluating research, and identifying new directions for research. Therefore, we recommend that opportunities to use existing government and private data banks be explored and, in addition, that new registries of health-related information be established.

We emphasize that the greatest needs and highest priorities are to synthesize and apply the information and data already accumulated, to increase interdisciplinary awareness and cooperation in biomedical research, and to integrate the data and findings of basic science with clinical practice and application.

Education and Professional Development: Because of the anticipated need for more medical service in high latitudes, it is urgent that attention be given to developing improved means of encouraging and supporting polar biomedical institutions, both private and public. At a minimum, professional societies should offer more encouragement for polar biomedical research through symposia and publications. Funds for polar biomedical research fellowships and education are, of course, crucial. Increasing awareness of scientific challenges of the Arctic and Antarctic is fundamental to promoting high-quality research and attracting the trained manpower that the field will require in the future. Because we believe that increasing health needs in the polar zones will require more biomedical personnel in these areas, we recommend a widespread effort to inform the relevant professional constituencies and to stimulate interest in biomedical careers in these regions. It is critical for young professionals and professionals-in-training to learn more about the challenges and opportunities in polar medicine, if the numbers of polar biomedical investigators and the level of effort in this field are to grow. We also believe that polar biomedical

research should be related to and serve as a foundation for policy and planning decisions regarding the structure of medical services in high latitudes. Thus, we recommend studies of the selection, training, and retention of clinical and research personnel.

Arctic and Antarctic Research: We recommend that Arctic research take precedence over Antarctic research for the immediate future. However, the special advantages of conducting investigations in the Antarctic are so great that increased biomedical research in the southern polar zones would be of value. The Antarctic generally provides an opportunity for better controlled studies and for more studies of the effects of isolation, particularly in international settings. In addition, the two polar zones can be used for comparative studies, especially those with a longitudinal model for either prospective or retrospective analysis.

Alaskan Native Participation: We strongly recommend provision for the participation of Alaskan Native groups in the planning and conduct of any biomedical research undertaken in Alaska. We regard such participation as crucial to the effectiveness, meaning, and application of the research. Thus, we endorse the health-related resolutions on the 1980 Inuit Circumpolar Conference and recommend that these be given special and urgent attention. We believe that action responsive to these resolutions would meet many of the problems and needs described in our report and would benefit the whole polar community. The principal thrust of these resolutions is as follows:

1. There should be more systematic and expert communication to the northern community about radiation exposure and its possible consequences in the Arctic.
2. Studies on the foster care of children should be initiated. There should be special emphasis on the etiology of separation of children from families and on how to reunite families.
3. In view of the long history of the use of herbs by the Inuit for medical purposes, the effectiveness of these preparations should be studied. Such research should include psychobiological and physiological studies before and after administration.
4. Means must be found to increase Inuit manpower in professional, administrative, and paramedical roles.

5. There should be an effort to increase the effectiveness of participating paramedical personnel.
6. Clinical practice and research would benefit from an international registry of illness events in the several national Inuit health authorities.
7. Alcoholism and malnutrition are critical problems requiring research.

Biological Sciences: Biological research is basic to the development of adequate environmental health controls, including management of water and wastes, and to achieving a better understanding of food and nutrition. We see as the highest priority the correlation of research findings from such fields as chemistry, physiology, mathematics, and physics with those from biology and the integration of basic biomedical research with applied research, environmental policy, and clinical practice.

Two environmental health problems related to biological sciences that require high-priority attention are water supply and waste disposal. Rapidly growing settlements invariably encounter problems related to safe and adequate water supply and waste disposal systems. There are large amounts of water in polar zones, but most is frozen and not readily available. Solution of water problems will require careful planning and major funding, in addition to research on problems of water quality and sanitation. We recommend that such steps be taken.

Related to water problems are those of accumulation of solid waste. During winter, such waste, including garbage and disposable diapers, near dwellings is a potential source of infection, provides insect-breeding grounds, and attracts animals. We recommend that studies be undertaken on ways to increase and sustain community interest in minimizing accumulations of waste and improving waste management.

Medical Sciences: The principal problems and highest priorities in medical sciences have been dealt with in part in the sections on data (including the need for a comprehensive registry of illness), education and professional development, and Alaskan Native participation in research. We concur with earlier findings (Committee on Polar Research 1970) on the need to learn more about the combination of photoperiodicity, cold, isolation, and chronobiology

(and possibly altitude), and we urge that in future studies of these variables greater emphasis be given to family dynamics and the work situation. We offer a number of specific recommendations responsive to biomedical needs we identified:

1. Healing of wounds: Anecdotal evidence suggests that healing of wounds is delayed in polar zones: we recommend efforts to document this effect, and to define its pathogenesis if it does occur.

2. Functional capacity of the immune system: Anecdotal and some scientific evidence suggests depressed immune functions in polar zones; we recommend that this condition be documented and its pathogenesis elucidated.

3. Circadian rhythm: We recommend that the possibility of alterations, especially in vital signs, hormone levels, sleep patterns, and mineral constituents of the body, be explored. Documentation of any year-round temperature changes is essential.

4. Photoperiodicity: We recommend that studies of effects of photoperiodicity be conducted in conjunction with those on circadian rhythms. Photoperiodicity and cold effects would be related to any polar-peculiar problems of medical management that might be identified. We note that in other animals light affects normal physiological functioning. If human functioning is also affected by light, such effects should be defined.

5. Electromagnetic fields: Electromagnetic fields with high flux might influence human physiological functioning. We recommend that the scope and magnitude of these effects be defined.

6a. Cold injury--protocols: Cooperative protocols, exploring clinical aspects of cold injury, could result in more efficient use of clinical and monetary resources; therefore, we recommend that these protocols be developed and that comparisons be made within and between northern and southern high latitudes.

6b. Cold injury--risk factors: Physiological, psychological, and social factors that indicate increased risks from cold injury should be defined so that susceptible populations can be identified. Risk profiles on newcomers and other groups could be developed. However, given the current state of the art, it is unlikely that in the next decade weather-sensitive and weather-resistant people could be

identified by medical procedures. However, we should continue working toward the development of procedures for rapid acclimatization.

6c. Cold injury--prevention: Industrial and military experience shows the importance of sustained cold-injury education programs. We recommend the development and expansion of education programs to reduce further cold injury.

6d. Cold injury--basal water balance: Basal caloric needs have been well studied, but daily water requirements are less well known and should be studied. The value of greater knowledge of water requirements for intravenous fluid therapy and frostbite prevention could be substantial; therefore, we recommend the initiation of such studies.

7. Follow up: Long-term follow-up studies of the physical and mental health of persons who have lived in the polar zones are necessary to determine any delayed effects of life in polar regions. We recommend that such studies be undertaken.

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Attachment A:

Polar Biomedical Research Facilities, Programs, and International Activities in the Arctic by Frederick A. Milan

**Institute of Arctic Biology
University of Alaska, Fairbanks**

INTRODUCTION

The International Circumpolar Health Symposia have been useful in the exchange of information between and among the circumpolar nations. The first symposium, the idea of C. Earl Albrecht, first Commissioner of Health, Territory of Alaska, took place in Fairbanks in 1967. In attendance were scientific workers from Finland, Denmark, Sweden, Norway, the Soviet Union, Greenland, Canada, Japan, and the United States. The second symposium was held in Oulu, Finland, in 1971; the third, in Yellowknife, Canadian Northwest Territory, in 1974; and the fourth in Novosibirsk, Soviet Union, in 1978. The fifth symposium took place in 1981 in Copenhagen, Denmark, and the sixth is scheduled for May 1984 in Anchorage, Alaska. The Scientific Committee on Antarctic Research (SCAR) will devote a day of this next symposium to discussion of recent Antarctic biomedical research. The World Health Organization (WHO) will also be represented.

From attendance at these symposia, one has the impression that a considerable amount of biomedical research is being undertaken in the circumpolar regions of the world. The Soviets, for example, are active in this type of research and have both a Siberian Branch of the Soviet Academy of Medical Sciences and an Academy Institute of Clinical and Experimental Medicine in Norilsk, another laboratory in Urkutsk, a State Medical Institute in Archangel, and a Department of Polar Medicine in the Arctic and Antarctic Research Institute in Leningrad. In 1978, at Novosibirsk, the Soviets published (with partial English translations) Bibliographic Index (1961-1977) Europeo-Asiatic North

of the USSR: Human Biology and Circumpolar Health. In 1977, in Moscow, N.R. Deryapa and I.F. Ryabinin published a 294-page book (in Russian), The Adaptation of Man in Northern Regions of the Earth.

The Finns, Swedes, Norwegians, Danes, and Icelanders are working cooperatively within the Nordic Council for Arctic Medical Research, located in Oulu, Finland. This Council has published 28 medical research reports between 1972 and 1981 describing, for example, ongoing medical research in the Nordic countries, a cardiovascular study conducted in Denmark in 1974-1975, the results of a psychiatric symposium on the epidemiology and suicidology of children and adults in the Far North, and a symposium on alcohol problems in northern regions.

The Canadians are pursuing Arctic biomedical research at the Northern Medical Research Unit at the Charles Camell Hospital in Edmonton and the Northern Medical Unit at the University of Manitoba in Winnipeg. In 1978, the International Grenfell Association and the Memorial University at St. John's, Newfoundland, established a Program of Northern Medicine and Health for Labrador. This program initiates and undertakes research projects to meet the overall objectives of improving the health and the quality of health care in isolated northern communities. The Association of Canadian Universities has recently established a Proposed International Network for Cooperation in Northern Sciences, including biomedicine.

In contrast, there is at present little biomedical research being conducted in Alaska, the U.S. portion of the circumpolar region. Earlier, federal funds supported the former research laboratories of the U.S. Public Health Service (USPHS), the Environmental Protection Agency (EPA), the U.S. Air Force (USAF), and the Office of Naval Research (ONR). The USPHS laboratory provided much of the research support for Alaska's attack on tuberculosis and other communicable diseases.

U.S. RESEARCH FACILITIES

Arctic Health Research Center: The Department of the Interior in 1947 engaged an Advisory Committee, named by the American Medical Association, to study "the overall medical conditions in the Territory of

Alaska." The report (Aronson 1947) stated that ". . . an Arctic Institute for the study of the Arctic and its bearing on health, sanitation, nutrition, engineering construction . . . is recommended." The Congress then invited the USPHS to submit a proposal for such an institute. A congressional appropriation in June 1948 (Public Law 648, 80th Congress) entitled Disease and Sanitation Investigation, Territory of Alaska led to the establishment of the Arctic Health Research Center (AHRC) in Anchorage in June 1949. The AHRC was moved to a new federal building in Fairbanks on the campus of the University of Alaska in 1967. A memorial plaque on the wall of the new building states:

Dedicated to the memory of J.P. Mountain, M.D.
(Assistant Surgeon General, U.S.P.H.S.). "The
far north . . . contains vast untouched reservoirs
of strategic materials and of minerals and vegetation
that can enrich the world. . . . These areas are
capable of supporting life, perhaps of supporting
flourishing civilizations. . . . Obtaining the
basic information necessary for healthful living in
low-temperature areas is a major objective of the
A.H.R.C. At the same time it can make potentially
significant contributions to basic knowledge"
(J.W.M. 1951).

During its 25 years, the AHRC was shuttled from governmental agency to agency, and, despite the protests of Senators Stevens (Alaska) and Magnuson (Washington) and letters from scientists in the Soviet Union, Finland, West Germany, and Canada, it was closed in 1973. The building, valued at \$9,312,000, and its equipment were then given to the University of Alaska. One of the reasons given for its closure was that the federal government thought that the state of Alaska should now support the center. The center had had a balanced program of research, training, demonstration, technical assistance, and environmental and behavioral sciences. The unique experiment in medical education known as the Washington, Alaska, Montana, and Idaho (WAMI) Medical Education Program owed its early success largely to the participation of the staff of the center, who not only directed it but also taught many of the first-year medical school courses.

During the period of the AHRC, Thomas Parran and his team from the Graduate School of Public Health at Pittsburgh undertook a massive survey of Alaska's health in 1954 (Parran et al. 1954).

Environmental Protection Agency Water Research Laboratory: The Water Pollution Research Laboratory in Fairbanks, a tenant in the AHRC building, was funded by the Clean Water Act of 1965. The functions of this act were transferred from the USPHSA to the new EPA in 1968. Initially, it was one of the seven water pollution laboratories established in the United States; it was closed in July 1979.

U.S. Air Force Arctic Aeromedical Laboratory: In 1948, a group from Randolph AFB in Texas arrived at Ladd Field in Fairbanks to establish the Arctic Aeromedical Laboratory (AAL). The mission was specifically related to USAF personnel in the Arctic and problems encountered in carrying out the agency's mission. The AAL was administered by the Alaskan Air Command, and then became part of the Aerospace Medical Division at Brooks AFB in San Antonio, Texas. It was closed in August 1967, and the building was given to the U.S. Army. The Army operated a cold weather frostbite center there until 1973.

During the life of this laboratory, independent and contract-supported scientists made significant contributions to cold thermophysiology, survival nutrition, and the creation of ingenious cold weather equipment, some adopted by the Defense Services. The Air Force probably closed the laboratory in 1967 because its mission at that time was tropical.

Naval Arctic Research Laboratory: The Naval Arctic Research Laboratory (NARL) was initiated by ONR in 1947 at Point Barrow, Alaska. The late Laurence Irving, its first director, Per Scholander, and others from Swarthmore College undertook some of the first important physiological and ecological research on Arctic organisms at that time. It supported studies on ice islands in the Arctic Ocean and became a well-used logistic center for the mounting of a great deal of Arctic research on the environment, climate, animals, and people of northern Alaska. The laboratory lost ONR support in 1980 and was closed. Now, the U.S. Geological Survey maintains a small group there to

conduct work on the former National Petroleum Reserve in Alaska, but the laboratory's earlier functions no longer exist.

Epidemiological Laboratory: The Center for Disease Control in Atlanta, Georgia, supports an Epidemiological Laboratory in Anchorage, located adjacent to the Alaska Area Native Health Service's major referral hospital in Alaska. The staff numbers about five M.D.'s, one Ph.D., and a small group of laboratory assistants and secretaries. The laboratory personnel conduct investigations of epidemiological problems as these develop.

Other Research Groups: The Alaska Area Native Health Service is concerned with health care delivery to the Alaskan Native population; however, some of its personnel carry out "avocational research" on Alaskan Native health problems.

The WAMI Medical Education Program staff at the University of Alaska conducts a limited amount of research when teaching duties permit.

The Institute of Arctic Biology's staff conducts research in basic biological mechanisms that are related, to some extent, to human health. Support is provided by the university, the state of Alaska, and federal grants.

ATTEMPTS TO DEVELOP INTERNATIONAL INTEREST AND COOPERATION

World Health Organization Conference (1962): The WHO Conference on Medicine and Public Health in the Arctic and Antarctic met in Geneva from August 28 to September 1, 1962 (WHO 1963). The conference covered a broad field, and representatives from 11 nations attended. The major health problems in Alaska, similar to those in other northern areas, were listed as (1) infectious diseases, (2) accidents, (3) sanitation, (4) mental illness, (5) effects of social disruption, (6) inadequate maternal care, (7) infant morbidity and mortality, (8) environmental health, complicated by unsafe water, permafrost, and low temperatures, (9) undernutrition, (10) defects of vision and hearing, and (11) dental problems. It was also pointed out that Arctic regions have unique problems with aboriginal populations.

World Health Organization Conference (1964): A meeting of a WHO Scientific Group on Research in Population Genetics of Primitive Groups was held in Geneva in November and December 1962 (WHO 1964). This session led to the cooperation of the small-population geneticists with the International Biological Program (IBP) and stimulated the book The Biology of Human Adaptability (Baker and Wiener 1966).

International Biological Program Studies: During the IBP (1964-1967), the human biology and health of Arctic people in the circumpolar parts of the world were studied by international scientific workers in multidisciplinary teams in the Soviet Union, United States, Canada, Denmark, Finland, and Japan. The results were summarized in a book published in 1980, The Human Biology of Circumpolar Populations (Milan 1980).

International Circumpolar Health Symposium: C. Earl Albrecht, head medical officer at the Matanuska Valley colonization project (1935-1941), surgeon, U.S. Army at Fort Richardson (1941-1945), Territorial Commissioner of Health (1945-1956), and Regent of the University of Alaska (1946-1956), convinced of the importance of discussing northern health problems with Soviets, Canadians, and Scandinavians, received a grant from the National Institutes of Health to hold the First International Symposium on Circumpolar Health in Fairbanks in 1967. These symposia were then held every three or four years thereafter. Most of the proceedings have been published (Proceedings of the First International Symposium on Circumpolar Health 1968; Proceedings of the Second International Symposium on Circumpolar Health 1972, 1973; Shephard and Itoh 1976). These international meetings, well attended by Soviets, Americans, Canadians, Scandinavians, and others, pointed out the great similarities in health problems in all these circumpolar nations and the usefulness of international solutions.

World Health Organization Meeting (1979): A working group met in Copenhagen on September 25-27, 1979, to discuss the health problems of local and migrant populations in Arctic regions (WHO 1979). Participants came from Canada, Finland, Sweden, Denmark, Norway, the

Soviet Union, and the United States. The resulting report stated that

. . . many past activities of the Regional Office for Europe of the World Health Organization have contained elements pertaining to health problems in the Arctic areas. Arctic medicine has, however, been a relatively low priority area with no comprehensive program. The Alma-Ata Declaration and the recommendation to pay attention to vulnerable and high-risk groups enhances the Regional Office's responsibility to develop policies for and initiate activities in circumpolar health.

It was decided to exclude environmental health problems, which could be dealt with in a workshop to be organized by the Regional Office in 1981. The following description was suggested for the areas, population, and health problems included in the term circumpolar health:

Circumpolar areas are characterized by extreme climatic conditions and a widely scattered population. The populations are natives in a process of acculturation and migrants in possession of an adequate technology for the exploitation of the natural resources of these areas. Most circumpolar health problems are not specific but are met with in other regions of the globe under similar circumstances. Only their combination is unique, justifying the term circumpolar health and specific actions.

The group outlined salient research tasks, suggested that key concepts in research strategies should include a "systems approach" and a "multidisciplinary approach," and developed a number of recommendations on circumpolar health. It stated also that WHO activities in circumpolar health should be of interest for Canada, China, Denmark (Greenland), Finland, Iceland, Mongolia, Norway, Sweden, the United States, and the Soviet Union.

American Society for Circumpolar Health: In 1980, at the American Association for the Advancement of Science (AAAS), Alaska Branch, Alaska Science Conference, an American Society for Circumpolar Health was established. Its purpose was to serve as a local

organization for U.S. participation in International Circumpolar Health Symposia, a clearinghouse for information on circumpolar health for Alaskans associated with various federal, state, university, or private organizations, and a stimulus for health-related research in Alaska. Its membership in March 1981 was 108 persons.

World Health Organization Program in Circumpolar Health: Hannu Vuori, Regional Officer for Primary Health Care in the WHO Regional Office for Europe, delivered a paper on the WHO Program in Circumpolar Health at the Fifth International Symposium on Circumpolar Health in August 1981. He wrote as follows:

The overall objectives of the new program are:

1. to reduce the prevalence and incidence of problems caused by deficient acculturation and adaptation, and by a deteriorating environment;
2. to increase the range, number and acceptability of available services;
3. to train more manpower (including health workers recruited from among the native population) which is better equipped as far as motivation, knowledge and skills are concerned;
4. to encourage lay-care and self-care; and
5. to encourage research on circumpolar health and to develop research methodology..

In Alaska, numbers 2, 3, and 4 have been implemented; the implementation of numbers 1 and 5 should be investigated.

EFFORTS TO DEFINE BIOMEDICAL RESEARCH NEEDS IN ALASKA

Although Alaska's total population in 1980 was only slightly more than 400,000, that number reflected an increase of 32 percent over 1970. In 1970, some 20 percent of the total population were Alaskan Natives. Current and anticipated population increases make more urgent the need for adequate provision for the planning and conduct of biomedical research. Such considerations have led to several recent efforts to define biomedical research needs in Alaska and draw attention to them.

The Alaska Council on Science and Technology, its members appointed by the governor, held a special Workshop on Human Life and Health in Anchorage in 1980. It provided a list of recommendations and research priorities (Alaska Council on Science and Technology 1980).

Wayne Myers, director of the WAMI Medical Education Program, has prepared a document (W.M. Myers, University of Alaska, Fairbanks, "Health Research in Alaska: A Proposal," unpublished manuscript) that contains his recommendations on priorities for health research in Alaska.

An informal workshop, "Research Goals and Objectives for the Next Five to Ten Years for Human Health," took place at the Alaska Science Conference in Fairbanks in August 1981. A list of research objectives resulted; the order was not intended to imply priorities:

1. Human nutrition.
2. Industrial medicine.
3. Social/physical stresses of environmental and social changes.
4. Basic biological mechanisms.
5. Human population studies.
6. Infectious disease.
7. Health personnel needs.
8. Immediate communication of research findings within Alaska.

Probably at this time Alaska's greatest need is to have a state-supported research center of some type, possibly within the university system, to organize its biomedical research activities. The alternative is a piecemeal approach to research by people associated with various federal, state, university, and private organizations or "outside" organizations. There are organizations that might serve as the foundation for this center, for example, the WAMI Medical Program, though its main focus is teaching, or the Institute on Arctic Biology at the Fairbanks campus. Years ago, because of the number of different human behavioral and biomedical researchers in Alaska, the Alaska Native Health Service, which had been delegated responsibility for Native health, organized a research committee to coordinate these activities. However, the problem of coordination of effort in a coherent program remains.

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Attachment B:

Issues in Circumpolar Health Research Related to Major Resource Development

by Joan Ryan

**Department of Anthropology
University of Calgary**

INTRODUCTION

For many years, the northern areas of Canada, Greenland, the United States, and Soviet Russia were considered barren lands unworthy of national interest or concern. In the interests of sovereignty, administrative posts were kept in isolated areas, and administrators dealt primarily with minimal demands of local Native peoples, intervening only in crises. More recently, the perceived need to maintain sovereignty more aggressively had led to the in-migration of greater numbers of civil servants, federal program people, non-Natives seeking the haven of undeveloped societies, and those interested in resource extraction. This paper addresses these recent developments; it outlines some of the major social issues evolving from large-scale and rapid social change.

OVERVIEW

The cumulative syntheses presented here derive from various sources. I reviewed the literature in several areas: boomtowns, culture change, environmental pollution, industrialization, case reports derived from in situ descriptions of major and rapid development, literature related to specific issues such as family structure and relationships in the absence of fathers and husbands, and the like. I have derived some information from past personal experience and current knowledge of the Canadian north, and I discussed observations with, as well as solicited other opinions

from, people currently involved in oil and gas development in the north of Alaska, Canada, and Greenland.

The literature was unwieldy yet yielded some new perspectives. It was interesting to note that the plethora of articles in various journals about psychosocial development of children in the absence of fathers drawn away by work on the high seas, in the military, or in isolated resource towns ended abruptly in the 1960s. We are all aware that certain types of studies tend to prevail in relation to funds available and their topical current interest; we note that no recent studies have been done on the families of individuals away for long periods in oil and gas fields. The pattern there is for men to leave for three to six weeks and then to have one to two weeks at home. The earlier reports on cognitive and social maturity favored explanations about the loss of maximal growth and development as a result of separation. One wonders what the effects of ambivalence of short-term forays in and out of home must be on small children and spouses. Although there is considerable literature on the anxiety syndromes of military wives, and on the mediating and adaptive roles of many women in the absence of their husbands, there is literally nothing in print on the current situation involving boomtown resource development personnel and their families.

It seems important, therefore, that we look in a systematic way at two populations: first, those individuals who grew up in the 1950s separated from fathers due to war, industry, incarceration, or other causes. In these instances, we should be able to assess the earlier, heavily psychoanalytic and linear research interpretations and predictions about the patterns of personal development and achievement in such situations. The second group would be contemporary families in which the absence factor is different and far more ambivalent; that is, the father is away for a short time, reappears for a shorter time still, and then exits again. There may be fundamental differences in family patterning in situations of this type and in reactions to paternal absence. The question of mediation on the part of females vis-a-vis their husbands and children might provide insights into some of the stress and anxiety syndromes seen in boomtown situations in the homes of resource personnel.

The data on the impact of separation on families at various stages of development are far from complete and mainly out of date. Such research could provide important information about stress, development, male-female roles, and optimum and preventive measures that might be initiated as part of company policy in the establishment of new towns.

A further, and related, focus for research might be the issue of kin support and fictive kin networks. There is considerable literature on these topics, and it appears in a variety of places: urban sociology, migration, family studies, new town studies, planning workshops, and the like. In essence, the literature assumes that people create fictive families in the absence of real ones and that these relationships alleviate the loneliness (the sense of isolation) and provide the support system necessary for coping with daily life. However, the literature available on rates of alcoholism, suicide, violence, and accidents, as well as the little available on mental illness, seems to contradict the findings of the family researchers and the optimism about the results of fictive kin networks. In any event, we have little information about the processes whereby people form such alliances and what gaps in personal commitments they fill. Clearly, in light of inflated morbidity and mortality statistics, fictive relationships do not appear to be functional in terms of preventing major crises and social pathology; therefore, whom do they serve and how?

The literature on boomtowns is outdated. The major published materials end in the 1960s, with the exception of current in-house reports on specific local situations. It does seem clear that what is needed is a policy analysis of decision making on the part of industries, governments, and municipalities regarding priorities set in town and camp planning. It is also clear that the so-called "soft services" are seldom given primary placement or funding and usually are established long after the incidence and prevalence of identifiable social pathology is so high that it must be confronted. Here, one might wonder at the need to clearly understand how political corporate decisions are made, what the priorities are, how they reflect human needs and aspirations, and what levels of social pathology are required before politicians and industrialists, and indeed the workers themselves, can or will take action. In conjunction with the need to

establish better measures and reporting systems for social trauma is the need to examine ways that preventive measures might be incorporated initially in the development plans. As soft services always include health, education, and welfare, one might also wonder about the need for some analyses of current values and the fit between them at the individual and corporate levels; it would seem that many people are prepared to pay a high personal price in exchange for a share of the economic pie.

Some of the literature is related to public participation in negotiating housing and soft services as part of an employee package. Although the concept of participation is shared by many, the process is seldom understood in terms of power and decision making, nor in terms of ultimate outcomes. In some instances, it would seem that the public participation process adds to, rather than decreases, stress and anxieties about development. Often the process bifurcates towns and makes the gap between long-term residents and newcomers in a given locale more bitter and opposed than would be the case without such participation. Sociopolitical stresses are played out in acts of personal violence among people in bars, on streets, and elsewhere. When factors of race or ethnicity are added to such oppositions, situations become ugly and affect the well-being of individuals and community.

There are a few studies that address the issues of "well-being" and "quality of life." Few explicitly define such terms in any measurable or adequately comprehensible manner. Much remains to be done to identify the perceptions and values people hold regarding these concepts. Although variables are often described, there seems to be little consensus on what constitutes "the good life" under situations of major development.

Systematic studies of female roles in industrial development of the hinterlands are also lacking. Traditionally, women have not been a major presence at the forefront of industry nor in those occupations that are related to northern extractive industries. Women have tended to be peripheral, playing the roles of wives, mothers, and functionaries in the soft services and in the lower echelons of administration. In recent years, women everywhere have been assuming central and major roles in executive positions and in the industrial

labor force. As a result, the extractive industries now have women in the oilfields, in the camps, and in the executive offices of northern areas. Such roles are essentially new and like all new introductions to cultural systems are not readily accepted. Human rights cases have been fought over the rights of women to be employed and to have satisfactory housing and facilities in industrial camps. Little of the literature addresses questions of health and welfare of the women in the field who are in physically demanding and competitive jobs and their effects on their male colleagues, as well as on other women, in the locality. It seems obvious that women left at home while their spouses work with highly skilled and often attractive and young female co-workers are likely to develop more marital conflicts than those whose husbands are part of an all-male workforce. The differences in salaries, freedom, and quality of life of employed females versus unemployed ones also lead to considerable stress, hostility, and confrontations among women in any given locale. This situation affects families, children, and the general community. Finally, research into the changing roles of women, with special reference to industrial heavy duty jobs, might yield some interesting results in terms of self-image, sexual definitions, adaptive strategies in conflict situations, ability to maximize personal strengths, definition of self, and strategies for maintaining physical and mental health.

There are many consultant reports and some published ones on what is popularly called social impact assessments (SIA). These studies address a large variety of socioeconomic concerns, issues of rights of Natives versus rights of the general public, matters of community change and concern, and the larger societal issues involved in establishing new communities. Often the detail is overwhelming, and somewhat misdirected; for example, if a local town has a 10-bed hospital, the question is asked, "How many more beds will it need to serve an increased population of 2000?" Such methodologies deny the importance of evaluating the need for differential services in health care delivery systems. In general, SIA and Economic Impact Assessment (EIA) reports tend to be isolated and to lack links to other reports of the same nature. They provide some insights about company and research

priorities but little information about the universal concerns that link major development efforts throughout the world. Nor are they predictive.

Finally, there are several excellent books and many papers on the effects of pollution, especially low-level radiation and pollution that affect lives in utero and living beings at any stage of development. Such reports alert us to the need to deal once again in power politics in order to maintain the physical well-being of individuals in given locales; for example, pollutants from northern logging companies have been responsible for mercury poisoning in major food sources, and sulphur dioxide plumes in the oil sands area are yet to be assessed for effects on humans, though negative effects on game and the food chain are documented.

It is my thesis that health care research and delivery systems not only must be linked to acute care and to preventive measures but also must be evaluated in the context of their own etiology. From this perspective, the need to identify a complex of factors in politics, culture change, and delivery of central services cannot be avoided.

THE CULTURAL CONTEXT OF RAPID DEVELOPMENT

The context in which health systems operate is important to the definition of types of services needed and/or provided. In many northern areas (and indeed in many parts of South America, Africa, and other areas), development occurs when a major extractive industry decides to locate its operation in a small town and introduces opportunities for employment, secondary services, and a large immigrant population. Thus, the first major change to be perceived is demographic. A major influx of population alters the base of local authority, the nature of the community, and often the political and social structure of local residents. In most situations in the north, local residents constitute a majority and are Indian or Inuit peoples. Relocation is often a reality. Where Native peoples have claim to the land base, litigation is often necessary, and negotiations seldom provide Native peoples the same influence or power in decision making that non-Natives have. From the outset then, the potential for personal and corporate violence is high.

The installation of a plant, the need for housing for employees, the wage structure of the corporation, the evolution of secondary services, all have major effects on local customs and practices. Although some individuals hasten to take advantage of the new situation, it is more common to find that local residents are underskilled and undereducated for the highly skilled extractive industrial positions. Language differences complicate matters. Minority, equal opportunity, or affirmative action programs seldom redress the problems of integrating local people into the corporate and industrial milieu.

Friction develops because of differences in language, socioeconomic skills and status, employability, and race. Although race per se is not a factor, the social reality is that the people who have least to gain and most to lose tend to be local residents of a minority racial group--and often are members of a group that has a mixed subsistence and cash economic base.

At the point of major contact, several situations emerge: there is a tendency for local residents to regard their life style, which was formerly acceptable, as diminishing in acceptability. There is also a tendency to regard race as an explanation for the diminishing quality of life; there is subsequently a surge of hostility, anxiety, depression, and the like. Loss of land, loss of subsistence foods, loss of kin ties, and loss of self-worth create problems of major magnitude at an individual and community levels for the middle generation. For young people, the problems differ: they evolve around issues of self-worth, employment, affluence, poverty, and interaction with a large group of people not formerly known. For the elderly, major development does not touch on self-worth and knowledge but impinges heavily on health and welfare in cases of relocation, loss of subsistence foods, and the decrease in shared relationships and incomes.

This scenario is a matter of record in many parts of the world. What is less familiar is a description of strengths held by indigenous peoples and of their abilities to adapt and adjust and to socialize their children in ways consonant with the changes. That many fail in achieving a new equilibrium is less surprising than that many succeed. The nature and mechanisms of

the successes are seldom reported and acknowledged in the accounts of social pathologies resulting from major social changes.

HEALTH ISSUES SPECIFIC TO DEVELOPMENT

In this section, I wish to show the connection between the cultural problems just described and the specific problems emanating from rapid social change in a northern milieu. It is necessary to divide the discussion into issues involving individual decisions and behavior (even when a large number of individuals are involved) and those that affect the community as a whole and in which there is corporate decision making.

Northern climates are believed to have negative effects on individuals because of cold, darkness, and geographic isolation. Reactions to these factors tend to be individual, although not unique. Most common reactions are depression, anxiety, and aggression. Most common resolutions are alcohol abuse, drug abuse, and abuse of self and others. Physiological reactions to cold and dark are also well documented. Research should focus on the development of better methodologies for recording and assessing, for example, the strengths of those who adapt well, innovative social programs that are preventive in nature, and innovative adaptation of methods of social control by agencies. The literature tends to affirm the negatives and seldom deals with the adaptive strategies people use to cope. Pathology is well described and documented, but prevention and coping seldom are. Redefinition of what constitutes the problems might be useful, as would comparative studies from many areas of the world. Prohibitive social measures seldom are solutions. For example, the solutions to prostitution in camps and resource towns surely do not lie in better security measures and firings of employees who consort but in options of housing and recreation for those who wish to associate in mixed company and those who prefer to remain in all-male or all-female enclaves. Public health systems established early might reduce the high rates of venereal diseases by advocating legalized prostitution, establishing birth control clinics and venereal disease centers, and lobbying for licensing as part of the legalization of prostitution. Mental health personnel could address such problems as well by

monitoring early symptoms of stress due to isolation from families. Thus, preplanning and identification of clusters of factors that relate to mental and physical health, as well as to housing, services, and agencies, would direct the choice of preventive services. If health services (and research) were broadly defined, as well as discretely utilized, the necessity for "front ending" the so-called soft services might prove economically and politically efficient and acceptable. This general view of what constitutes health does not deny the realities of more specific physiological and psychological research and programs and services that are necessary in conditions of rapid development in northern areas.

More specifically, major health research issues need to focus on the following:

1. Geography and climate: Adaptive mechanisms and idiosyncratic responses need to be studied continuously to gain comparative and longitudinal information (i.e., data collected over an extended period of time) on reactions, coping mechanisms, and adaptive responses.
2. Family matters: More information is needed to understand the stresses caused by the long-term and short-term separation experienced by spouses and children. Little is known about vulnerability and ability for human growth and development under situations of stress, conflict, and ambivalence occasioned by employment related to resource development. For example, do executives suffer more stress in the field or in the home offices; what coping responses are available and used effectively by them? What degree of overlap exists between executive, professional, and skilled laborers in their attempts to minimize stress, and what factors differentiate them? Is family location a key factor in adaptability to northern work, or does absence of spouse and children make the situation easier? What are the sex-role differences that allow for adaptation or conflict in situ or at home after separations? What are the payoffs for males and females for absences, or for presences? How much deviant behavior occurs when individuals are released from normative demands and placed in isolated situations where sexuality, boredom, alcohol, and job stresses may combine to create pseudo-normative camp behaviors? What prices do individuals pay for such deviance and what is the cost

factor to the community and to the companies in terms of illness, absenteeism, and worker turnover or "burn-out"? Would it help to have family housing, daycare centers, integration of spouses into the workforce, reeducation, and better schools, health services, and recreation? What are the accurate indicators of mental health and/or social pathology in such circumstances?

3. Environmental factors: Much information has been compiled on local flora and fauna and on various effects of industrial activities. However, few of the data have been integrated, with the result that few reports resolve their own contradictions. For example, a report may state that resource activities will drive game out of an area, destroy their food source, or alter fish routes; another part of the same report will advocate the benefits of hunting and fishing for good mental health. The literature on low-level pollutants indicates clearly the dangers experienced by humans and other mammals who live in certain areas of development. However, such data are hard to collect, hard to define, hard to publish, and hard to sell to the decision makers. People grow sick, abort, and develop strange symptoms, and local companies utter reassurances. We have seen it with strontium 90 in milk, with mercury poisoning in fish eaten by Natives, and in natural abortions and early births near Three Mile Island. The human physiological reactions can be identified and documented and sometimes corrected. However, too often no action is taken until a large-scale crisis develops. Could a public health monitoring system, with personnel skilled to analyze industrial diseases, effect any changes?

4. Violence: Violence can be divided into acts against self, including drug and alcohol abuse, suicide, and overwork, and acts against others, such as assault, homicide, and abandonment. The documentation of towns and cities in boom development categorized by major in-migration of workers, rapid growth of housing sites and secondary services, and lack of recreational facilities and so-called soft services indicates clearly that venereal disease rates, suicide and homicide rates, accident rates (usually involving alcohol and/or fatigue), and rates of abuse of co-workers and spouses are high and constitute major problems. There is also an increase in the incidence and prevalence of petty crimes, break and enter

activities, prostitution, and public drunkenness. Company, community, and agency responses to these acts of violence have not been innovative or particularly effective. Many of the problems emanate from poor planning, infrastructure, and decision making. All the problems are predictable, and yet few are dealt with in the initial planning stages of development or with any sense of priority. Clearly, most of these activities constitute human reactions to a particular milieu, which often draws in people who have had prior involvement in such activities. Violence may also reflect the inability of local people to adapt to the major stresses of rapid change with appropriate behaviors in the absence of prior experience. Many of these activities need not be abusive. For example, prostitution tends to become violent only when it involves pimps, harsh and unimaginative police action, and racism. Disease, injuries, and complex medical problems evolve from all the situations requiring both acute care and long-term public health measures.

5. Women: As a group, women constitute an interesting subject area for research. Many women are in the bush camps and new towns as highly skilled riggers, cooks, bullcooks, geologists, executive secretaries, and the like. Many also are in these areas as nurses, teachers, wives, or mothers. Some come with their husbands to live under less than comfortable situations with small children. No doubt, measures of adaptability and response to stressful conditions could be established for each group. Definition of problems would certainly vary among them, but one would expect considerable overlap as well. Differential rates of stress (from those of male co-workers) and different responses to competition, long hours, and camp conditions might provide some interesting data. Rates of illness, types of illness, degree of alcohol and drug abuse, absenteeism, and anxiety all require some type of medical intervention in a holistic medical scheme. Data for women have not been collected systematically, nor are those available as predictive as similar profiles for males.

SUGGESTED CATEGORIES FOR RESEARCH

Suggested categories for research, which should be controlled for age, sex, and income, follow:

Physical environment: adaptive and nonadaptive mechanisms in regard to

- cold
- dark
- work schedules
- housing
- food and nutrition
- pollutants

Social environment: adaptive and nonadaptive reactions to

- group living
- family absence
- family presence
- inverted male-female roles
- quasi new sexual mores
- quasi new drinking mores
- lack of activity
- lack of structure
- isolation

Affluence and mobility: adaptive and nonadaptive factors in

- short-term high salaries
- family relationships
- sexual roles
- conflict situations
- competition

Factors involved in "acting out" responses to stressful situations

- alcohol and drug abuse
- accidents
- prostitution
- nutrition changes
- absenteeism
- marital conflict
- family conflict
- pregnancies
- venereal disease
- neuroses and psychoses
- ulcers, stress syndromes
- violence
- racism

ambivalence concerning normative behavior
development of new strengths and behaviors
mobility, restlessness

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biology, and social science, to reiterate what is known, to suggest needed research, and to identify any barriers to the implementation of polar biomedical research and the application of its findings.

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